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EXAMINER

MAGEE, THOMAS J

ART UNIT PAPER NUMBER

2811

DATE MAILED: 04/07/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

Application No.

10/621,696

Applicant(s)

LIOU, HUEY-CHIANG

Examiner

Thomas J. Magee

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☐ Responsive to communication(s) filed on \_\_\_\_.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-25 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-25 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \*    c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
  - ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_.
  - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. ____. |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date ____. | 6) <input type="checkbox"/> Other: ____.  |

## DETAILED ACTION

### *Claim Objections*

1. Claim 1 is objected to on the basis of minor informalities. The phrases referring to *"sacrificial dielectric decomposition,"* in the recited phrases, *"decomposing portions of the sacrificial dielectric material to form sacrificial dielectric decomposition,"* and *"removing portions of the sacrificial dielectric decomposition,"* are both ambiguous and lack clarity in further limiting the claim. Correction or clarification is required.

2. Claim 20 is objected to on the basis of minor informalities. The phrase, *"....wherein the contact structure metallic C4 structure,"* is unclear as to meaning. It appears that a simple omission may be present. Correction is required.

### *Claim Rejections – 35 U.S.C. 102*

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

4. Claims <sup>1-10, 12-19, 21-25</sup><sub>1</sub> are rejected under 35 U.S.C. 102(e) as being anticipated by Grill et al.  
(US 6,413,852 B1).

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5. Regarding Claim 1, Grill et al. disclose a method of forming an air gap interconnect structure wherein a multilayer interconnect is present adjacent to a substrate layer (100) (Figure 1E) with conductive layers (185) positioned in two conductive vertical series with the conductive vertical series isolated from each other by dielectric material (110,120,130, 140) (Figures 1A – 1E) with a protective (masking) layer formed adjacent the interconnect (Col. 5, lines 25 – 31) that is patterned to expose portions of the sacrificial dielectric material (columns adjacent to cavities 150,160), whereupon, the portions of dielectric are removed to form air gaps (190) between the conductive layers.

6. Regarding Claim 2, Grill et al. disclose the formation of a multi-layer interconnect, comprising forming a first layer of sacrificial dielectric material (110,120,130,140) (Figures 1A,1B) with trenches (150,160) (Figure 1C) formed in the dielectric, whereupon the trenches are filled with conductive layers (185) isolated from each other by sacrificial dielectric material (Figure 1E). Grill et al. further disclose forming a second layer of sacrificial dielectric material (110',120',140') (Figure 1J) (Col. 6, lines 61 – 66) adjacent the conductive layers and overlying the first dielectric layer wherein trenches are formed in the second layer and filled with conductive material (185') (Figure 1L) to form two additional layers isolated from each other by a sacrificial dielectric layer (220').

7. Regarding Claim 3, Grill et al. disclose the formation of two conductive layers in each conductive vertical series.

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8. Regarding Claims 4 and 5, Grill et al. disclose that decomposing comprises removing substantially all of the dielectric material between each (Figures 1F,1K) of the vertical series.

9. Regarding Claims 6 and 7, Grill et al. do not explicitly disclose that hydrofluoric acid and water are used to decompose or remove dielectric material, however, Grill et al. do disclose that etchback may include wet etching (Col. 5, lines 64 – 67). Since the dielectric layers include silicon dioxide (Col. 4, lines 63 – 67), it is inherent that an etchant such as HF and water would be used in removal.

10. Regarding Claim 8, Grill et al. disclose that the removal of dielectric layers comprises introducing a carrier plasma (Col. 5, lines 64 – 66).

11. Regarding Claim 9, Grill et al. disclose that the conductive layers are formed of copper (Col. 5, lines 41 – 43).

12. Regarding Claim 10, Grill et al. disclose that the sacrificial dielectric material is composed of silicon dioxide (Col. 4, lines 63 – 67).

13. Regarding Claim 12, Grill et al. disclose the formation of vertical support structures (210) (Figure 1G) (Col. 6, lines 22 – 27) peripheral to the conductive vertical series.

14. Regarding Claims 13 – 15, Grill et al. disclose the presence of a capping layer (250)

atop the conductive layers and support structures (Figure 1M) of the most highly positioned conductive layers, wherein three capping layers are present, each adjacent to the other (Col. 7, lines 10 – 16).

15. Regarding Claim 16, Grill et al. disclose the formation of a contact structure (290) (Figure 3A) through the protective and capping layers to the underlying conductive layer.

16. Regarding Claims 17 – 19, Grill et al. disclose (Col. 7, lines 10 – 16) (Col. 4, line 63 through Col. 5, line 15) that the first and third layers comprise polyimide and the second layer comprises silicon dioxide.

17. Regarding Claim 21, Grill et al. disclose an air gap interconnect structure comprising a substrate layer and two conductive vertical layers (Figure 3A), each conductive vertical series comprising a plurality of conductive layers, where the vertical series are isolated from each other by air gaps defined at the side walls.

18. Regarding Claim 22, Grill et al. disclose that vertical support structures (210) (Figure 3A) are present peripheral to the conductive vertical series and a capping layer (250) adjacent to and above the upper surfaces of the vertical support structures and conductive vertical series (Figure 1M and 1O).

19. Regarding Claim 23, Grill et al. disclose (Figure 3A) that each vertical series comprises

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two conductive layers.

20. Regarding Claim 24, Grill et al. disclose vertical support structures (210) peripheral to the conductive vertical series (Figure 3A) where the support structures protrude slightly more than the uppermost conductive layer (right side, Figure 3A), as shown in the detailed cross section of Figure 5A, wherein the structure, 210, is slightly elevated above the conductive layer.

21. Regarding Claim 25, Grill et al. disclose the presence of a contact structure (290) (Figure 3A) extending through the capping layers to contact an underlying conductive layer.

### ***Claim Rejections – 35 U.S.C. 103***

22. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office Action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

23. Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Grill et al., as applied to Claims 1 – 10, 12 – 19, and 21 – 25, and further in view of Hsue et al. (US 6,696, 222 B2).

24. Regarding Claim 11, Grill et al. do not disclose the presence of a silicon carbide protective layer. Hsue et al. disclose the presence of a sealing (protective) layer (52) atop a

conductive layer (Figure 1L) and composed of silicon carbide. Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to combine Hsue et al. with Grill et al. to obtain a stable diffusion barrier and sealant layer.

25. Claim 25 is rejected under 35 U.S.C. 103(a) as being unpatentable over Grill et al., as applied to Claims 1 – 10, 12 – 19, and 21 – 25, and further in view of Greer (6,689,680 B2).

26. Regarding Claim 25, Grill et al. do not disclose the use of a C4 contact on the device structure. Greer discloses the use of C4 bump contacts (510) (Figure 5) on a contact structure. It would have been obvious to one of ordinary skill in the art at the time of the invention to combine Greer with Grill et al. to obtain a compatible bump contact for connection to external sources.

### ***Conclusions***

27. Any inquiry concerning this communication or earlier communications from the Examiner should be directed to **Thomas Magee**, whose telephone number is **(571) 272 1658**. The Examiner can normally be reached on Monday through Friday from 8:30AM to 5:00PM (EST). If attempts to reach the Examiner by telephone are unsuccessful, the examiner's supervisor, **Eddie Lee**, can be reached on **(571) 272-1732**. The fax number for the organization where this application or proceeding is assigned is **(703) 872-9306**.

Thomas Magee  
March 25, 2004

Primary Examiner  
*Steven Lope*